ONR Geoclutter Program: Final Analysis of Geophysical and Geological Data

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LONG-TERM GOALS

The primary goal of the Geoclutter program is to assess geologic clutter/reverberation issues in a seismically and geologically well-characterized shallow-water environment. The mid-outer continental shelf off New Jersey provides such an opportunity, because both bathymetry (a known and prominent cause of backscatter) and portions of the shallow subsurface have been mapped in detail as a result of STRATAFORM. The Geoclutter program consists of three field program phases:

(I) an acoustic reconnaissance survey utilizing Navy gray ships and assets to identify potential geoclutter hot spots;

(II) a full bistatic acoustic experiment focusing on the chosen areas, and

(III), the focus of the work described here, detailed geologic and geophysical surveys of the hot spots identified in Phases I and II.

OBJECTIVES

Our primary objective for this grant were to finalize analysis of geological and geophysical data collected as part of the ONR Geoclutter program. In particular, we intend to complete the interpretation of the 2001 and 2002 chirp seismic data in conjunction with the analysis of cores collected in the region. These products will provide critical constraints on geoacoustic modeling of the New Jersey shelf region, which continues to be a focus of ONR-sponsored acoustic field work.

APPROACH

We have employed a variety of approaches in our work. Stratal horizons are interpreted from chirp seismic data using commercial seismic interpretation software. Seafloor measurements, including grain size, porosity, *in situ* velocity and attenuation, backscatter strength, and acoustic impedance, are compared with each other using correlation analyses Cores have been both logged for geoacoustic properties, providing ground truth, and sampled, to corroborate geologic interpretation and provide age dating of the sedimentary strata evident in the chirp data.

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14. ABSTRACT
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WORK COMPLETED

Interpretation of the chirp data has continued with significant progress. The analysis of seafloor properties based on *in situ* acoustic data, grab samples, short cores and remote sensing data (chirp and backscatter) is complete. Three long cores, ranging in length from 4 to 13 m, were collected in 2002 aboard the *R/V Knorr* using the AHC-800 system supplied by DOSECC (Fig. 1). These cores are the longest high-quality cores collected from this part of the margin and represent a unique sample set to provide temporal, stratigraphic and environmental context both for seismic stratigraphic interpretation and future sampling efforts. Geotechnical measurements from these cores were logged at sea, and samples have recently been collected which have undergone detailed analyses for time stratigraphy, sediment texture and paleoenvironmental conditions.

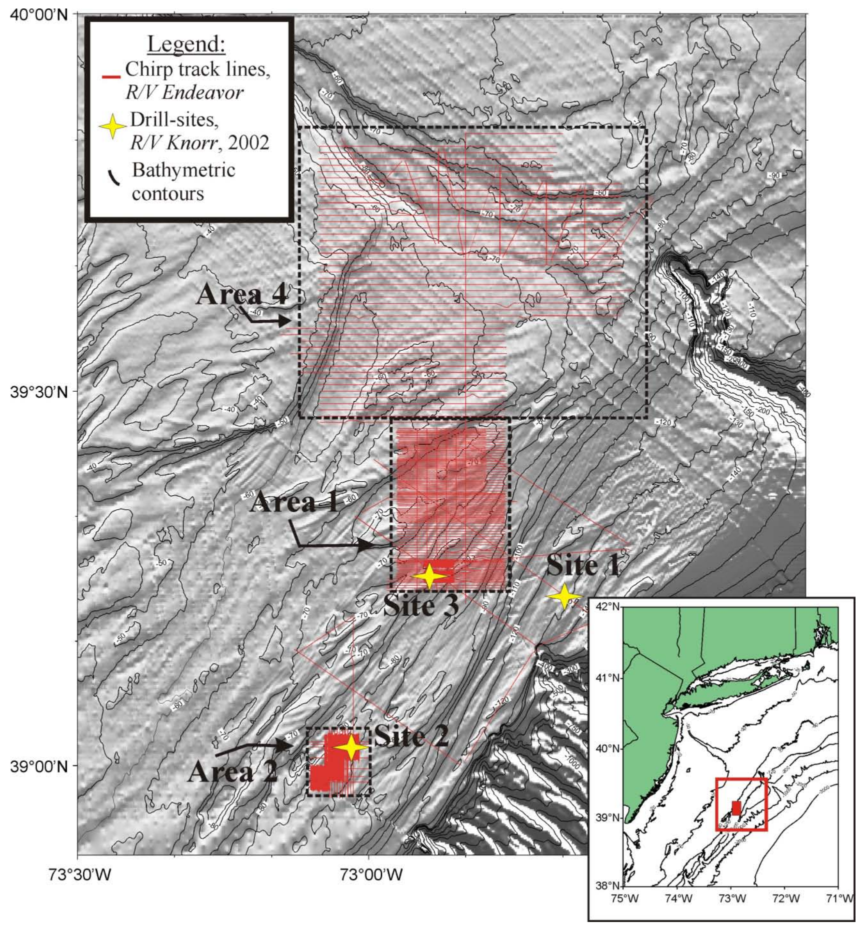

Figure 1. Location of deep-towed chirp-sonar tracklines collected aboard R/V Endeavor (EN359 and EN370), superimposed on NOAA's bathymetry of the New Jersey middle and outer continental shelf. The small inset locates our study area regionally. Drill sites 1-3 cored with the AHC-800 system aboard R/V Knorr in fall 2002 are marked as yellow stars.

RESULTS

Previous progress reports have detailed our extensive results to date (Fulthorpe and Austin, 2004; Goff and Nordfjord, 2004; Goff et al., 2004; Nordfjord et al., 2005; Goff et al., 2005; Gulick et al., 2005). Here we focus on the latest results from an extensive analysis of the internal stratigraphy of fill units within the channel networks that are shallowly buried across most of the middle and outer shelf. These results are presented in a newly submitted manuscript (Nordfjord et al., in press).

The fill strata of incised valleys on the New Jersey outer shelf demonstrate an upward and landward progression of four sedimentary facies (Figure 2), as observed in 1-4 kHz deep-towed chirp seismic data. From oldest to youngest, these are interpreted as fluvial lags (SF1), estuarine mixed sand and muds (SF2), estuary central bay muds (SF3) and redistributed estuary mouth sands (SF4). These fill units are covered by a transgressive oceanic ravinement surface, “T”, and Holocene marine sand deposits. Seismic facies of the transgressive systems tract (SF2-SF4) are interpreted to represent fluvial, estuarine and shelf depositional systems that are bounded by seismic reflectors marking source diastems or unconformities.

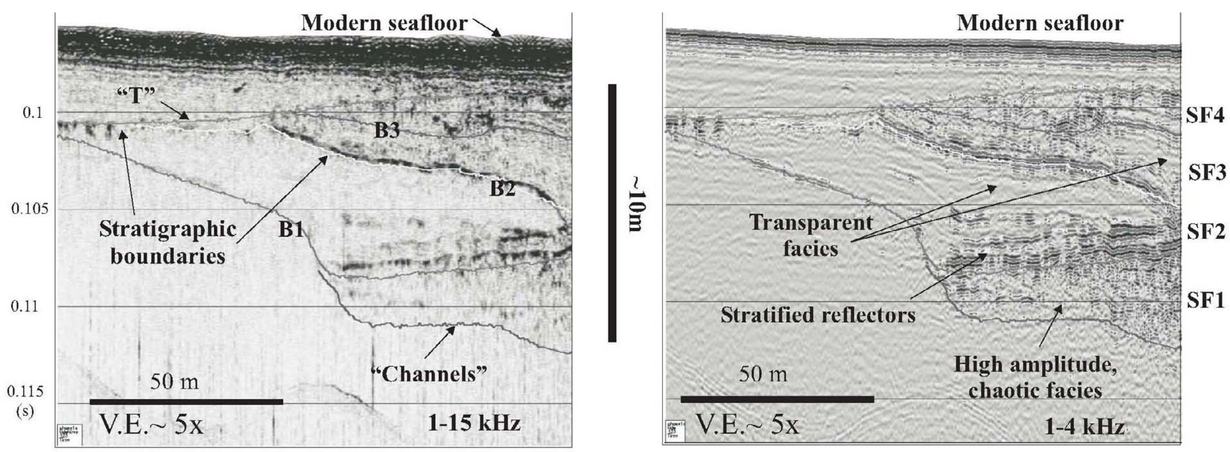

Figure 2. Representative collocated chirp images at crossing the edge of a buried fluvial channel. The 1-15 kHz data were used as a guide for interpreting significant seismic boundaries, while the 1-4 kHz data provided more detail of the seismic facies.

Transgressive paleovalley-fill successions identified in the New Jersey outer shelf Quaternary section contain three transgressive surfaces identified best in the 1-15 kHz chirp data (Figure 2), B1-3, interpreted as bay ravinement, intermediate flooding surface and tidal ravinement, respectively, which are wholly or partly preserved in vertical succession. These incised-valley-confined diastems significantly modify the antecedent, regionally developed, fluvial erosion surfaces. This modification is affected by erosion accompanying submergence and hypsometric change as the paleo-river valley evolves into a paleo-estuary. The original fluvially-incised surface, “Channels”, is generally only preserved as a distinct surface within valley axes, beneath a partly preserved fluvial depositional system. The fluvial erosion surfaces have typically been modified by bay (B1) and tidal (B3) ravinements within incised valleys, which then becomes a composite erosional surfaces cut by fluvial, estuarine and shoreface-shelf processes. The regionally developed “T” horizon caps subjacent incised-valley fill successions and marks landward passage of an oceanic shoreface over the underlying infilled paleo-estuaries. Dipward changes in the thickness of the SF3 and SF4 units suggest either a stillstand in the passage of the shoreline, which allowed for variations in unit thicknesses, or that the valley shape controlled the hydrodynamic conditions for sediment transport and deposition. In particular, we suggest that narrower valleys will promote tidally-dominated, fine-grained deposition while broader valleys will attenuate tidal flow velocities, allow the estuary to be dominated by wave energy and promote coarse-grained deposition. Our study demonstrates wave- and tide- dominated facies can coexist within the fill strata. A model for the development of valley fill strata is presented in Figure 3.

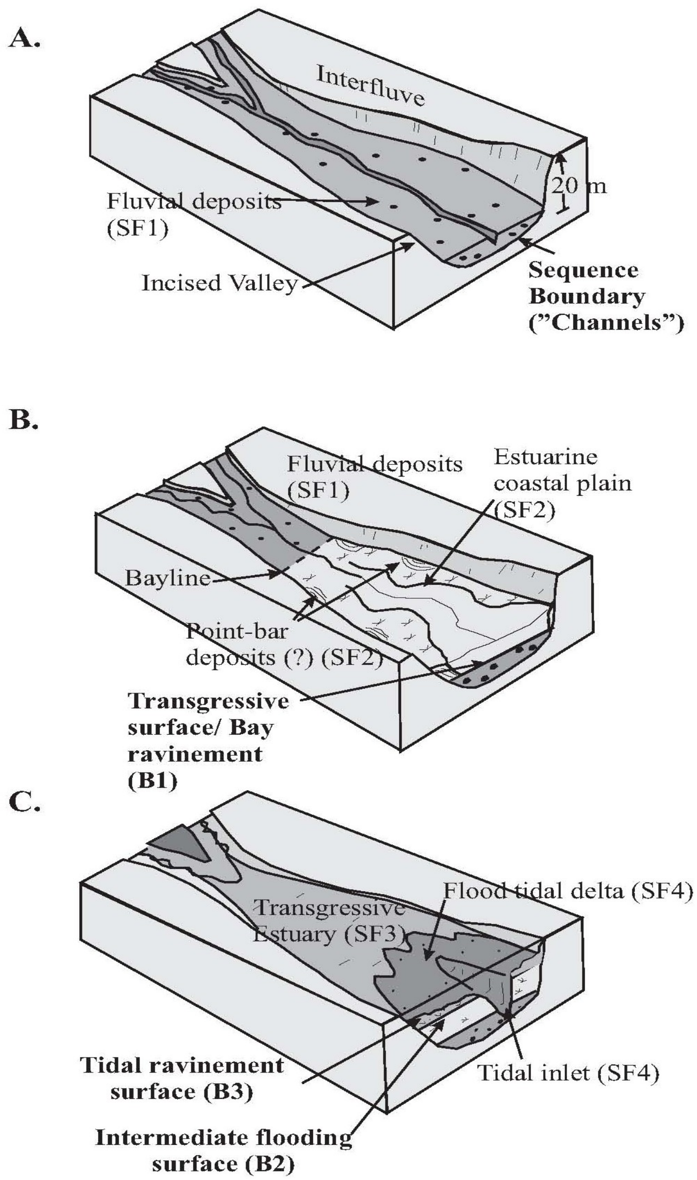

Figure 3. Schematic representations of the evolution of New Jersey outer shelf incised valley systems, including their stratigraphic boundaries and sedimentary facies, as they went from (A) fluvial systems with preserved fluvial lags to (B) more aggradational stage as the system started to get backfilled and finally to (C) a typically passive infilling stage with the central basin mud and estuary mouth complexes. Not shown is the formation of the transgressive oceanic ravinement, following infilling, which likely reworked and removed significant portions of the incised valley fill deposited.

IMPACT/APPLICATIONS

The primary application of our geological and geophysical characterization is in the establishment of critical paleoenvironmental characteristics for the understanding of acoustic interactions with the seabed. For example, the model presented in Figure 3 can be used as a basis for predicting the geoacoustic properties of sediments within the buried channels, as well as predict physical property contrasts between those sediments and the host strata that could give rise to a significant acoustic response.

RELATED PROJECTS

The ONR STRATAFORM program provided initial site characterization for the Geoclutter natural laboratory. The SWAT acoustic experiment was also carried out in this area, and the 2006 Shallow Water Acoustics experiment is now planned for this area.

PUBLICATIONS

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Nordfjord, S., J. A. Goff, J. A. Austin, Jr., and S. P. S. Gulick, Seismic facies analysis of shallowly buried incised valleys, New Jersey continental shelf: understanding late Quaternary paleoenvironments during the last transgression, submitted to J. Sed. Res.